

THE WEATHER AND CIRCULATION OF JULY 1954¹

One of the Hottest Months On Record in the Central United States

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SUMMARY OF UNUSUAL WEATHER FEATURES

One of the most striking facets of the circulation during July 1954 was the persistence of weather type over many regions of the Northern Hemisphere. The results of this persistence were widely noted and deserve mention.

Great Britain experienced cold and stormy weather with only very brief interludes of more pleasant conditions. Central Europe was similarly plagued. Since June weather also had been stormy in Europe, 70 continuous hours of rain and snow on the Alps in early July sent the Danube well over its banks. This flood was characterized as the worst in centuries. At one time the river flooded a stretch of some 300 miles from Vienna upstream. As the crest passed downstream both Vienna (July 14) and Budapest were hard hit and surrounding farm lands were inundated.

Late July floods were also reported from Iran and from East Pakistan and eastern India but these were dwarfed by the accounts of Chinese disasters. Apparently wide areas of China were deluged with rain in early July and the rising waters congregating in the 3,100-mile long Yangtze River left widespread destruction. Hundreds of miles of the Yangtze Valley were flooded and a new all-time high water mark was recorded at Wuhan as late as mid-August.

In contrast to the cold and floods so prominent elsewhere, the United States was troubled by heat and drought. Their greatest effects were felt in the 6-State area; Nebraska, Kansas, Oklahoma, Louisiana, Missouri, and Arkansas, as well as northern and western portions of Texas. Above normal temperatures were both persistent and extreme—on the 14th St. Louis recorded 115° F. and East St. Louis 117° F., the highest temperature ever recorded on or east of the Mississippi River. Deficient rainfall combined with searing heat compounded the drought conditions remaining from June [1].

THE HEMISPHERIC CIRCULATION

Figure 1 shows the mean 700-mb. flow pattern for July. At polar latitudes there were two troughs present which

resolved into a five-trough pattern in the westerlies of middle latitude. Of the ridges between these troughs the continental ridges (Canadian, Eurasian, and East-Asian) were accompanied by well-marked height departures from normal (dashed lines in fig. 1) centered farther north than their Atlantic and Pacific counterparts. The general warmth of the higher-latitude continental ridges is attested to by the 200-mb. ridges of figure 2. Over both oceans the maritime Highs of sea level (Chart XI) and 700 mb. were conspicuously absent at 200 mb. Contrarily, anticyclonic conditions intensified up through the 200-mb. level over the United States. Similar relationships were noted in July 1953 [2].

Cold stormy weather over Britain and Europe was associated with the trough which tilted negatively from the Icelandic Low to the Balkans. The departures from normal suggest a much stronger than normal north-westerly (cyclonic) influx of marine air into western and central Europe. The Chinese flood seems most closely related to the deeper than normal monsoon trough over Asia and the blocking High west of Sakhalin (fig. 1). This configuration, together with the minor trough over Korea, apparently led to the stronger than normal southeasterly components (both at sea level and aloft) north of 35° N. and stronger southwesterly components south of 35° N. These conditions could be regarded as a concentrated localization of the normal monsoon circulation.

The upper level circulation affecting North America was of the most frequent summer type, i. e., a trough off either coast with a warm High over the United States (most recent exception was July 1950). July 1954 was distinguished, however, by a number of features: (1) the abnormal strength of the troughs, (2) the Canadian ridge which was farther east and stronger than normal (+260 feet), and (3) the persistence of this pattern and its cumulative effect.

CIRCULATION PATTERN OVER THE UNITED STATES

At 700 mb. the dominating circulation feature was the upper level High centered over southern Missouri. This anticyclone was stronger than normal (+80 feet) and

¹ See Charts I-XV following p. 217 for analyzed climatological data for the month.

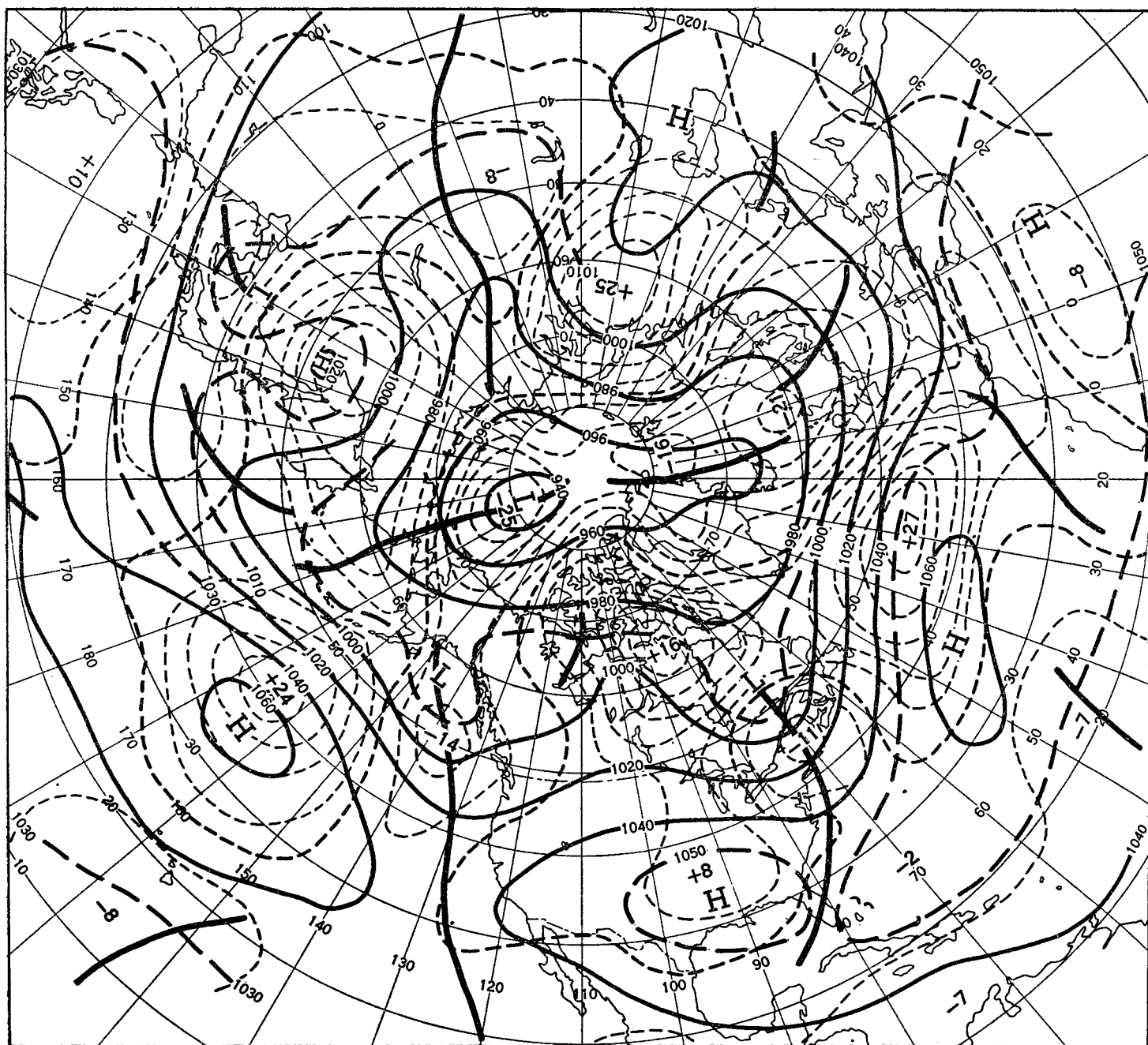


FIGURE 1.—Mean 700-mb. contours and height departures from normal (both in tens of feet) for June 29—July 23, 1954. Anticyclonic circulation over the United States with a trough off either coast appeared to be a stable regime with hemispheric interrelations which prevailed most of the month.

(characteristic of the 1954 summer) had a well-defined east-west axis of above normal heights which was centered about 35° N. The High seemed even stronger at higher levels (fig. 2), as previously mentioned, but was only weakly reflected at sea level. In fact, sea level pressures were below normal (Chart XI, inset)—an obvious effect of a warmer than normal troposphere. (See also June 1954, [1].) Figure 3 affords a comparison of the relative vorticities at 700 and 200 mb. The strengthening of the anticyclonic and cyclonic vorticity centers at higher levels is quite common but not always so well marked. It may be interesting to note that although the maritime Highs

(Chart XI) almost disappeared at 200 mb. (fig. 2), the shear to the right of the "mean jet" was associated with the maintenance of anticyclonic vorticities throughout the troposphere.

This "jet" (fig. 2) along the Canadian-United States border was somewhat stronger than normal but very close to its normal position. The contribution of such a jet to the maintenance of an upper level High to its right (over the United States) has not been thoroughly investigated. However, its role in long-sustained circulation patterns where persistent fields of divergence prevail through deep atmospheric layers appears to be an impor-

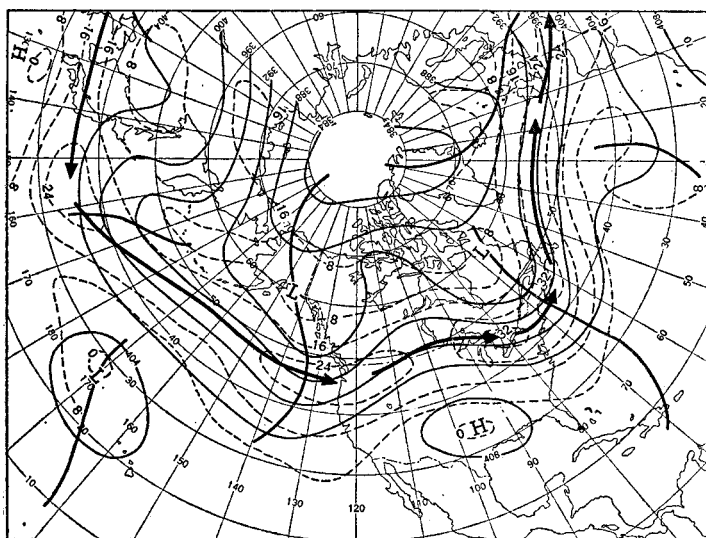


FIGURE 2.—Mean 200-mb. contours (in hundreds of feet) and isotachs (dashed, in meters per second) for June 29-July 28, 1954. Intense "jet" along United States-Canadian border was stronger than normal. Note United States High (fig. 1) intensified aloft while maritime Highs almost disappeared.

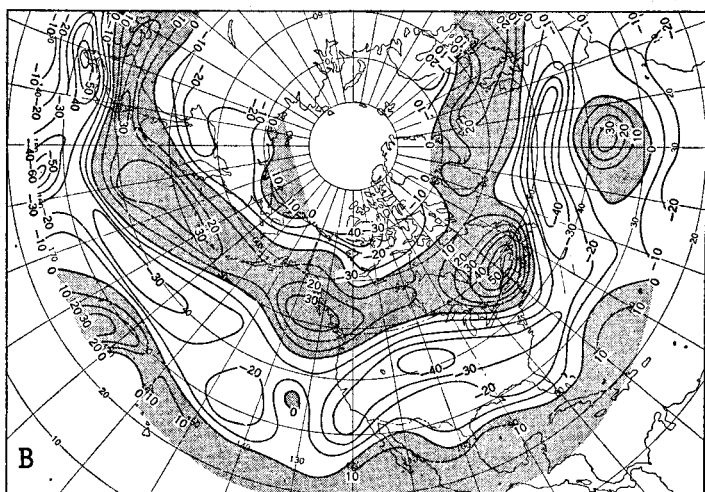
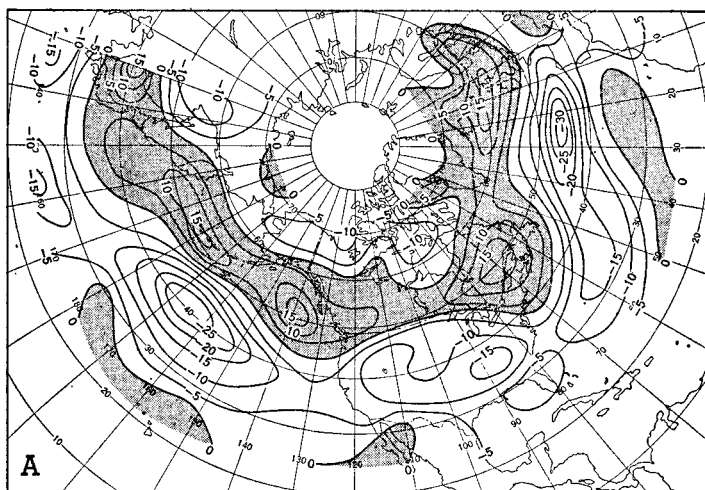


FIGURE 3.—Vertical component of mean relative geostrophic vorticity June 29-July 28, 1954. (A) 700 mb. Isoleths are drawn for units of $5 \times 10^{-6} \text{ sec}^{-1}$. (B) 200 mb. Isoleths are drawn for units of $10 \times 10^{-6} \text{ sec}^{-1}$. Anticyclonic vorticity increased markedly aloft over the continental anticyclone and increased more slowly over the maritime Highs which have almost disappeared at 200 mb. (fig. 2).

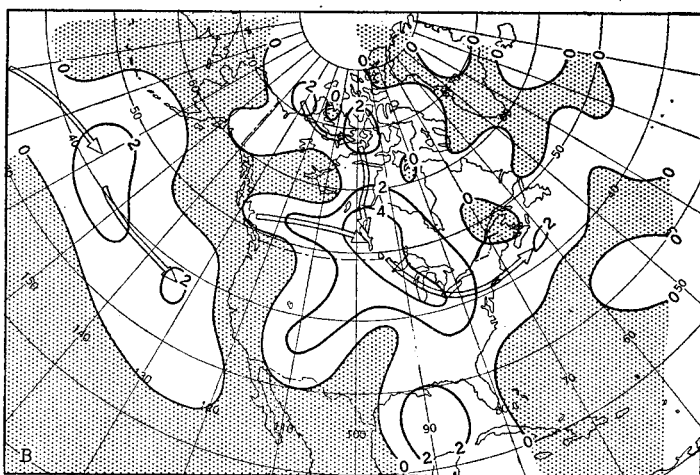
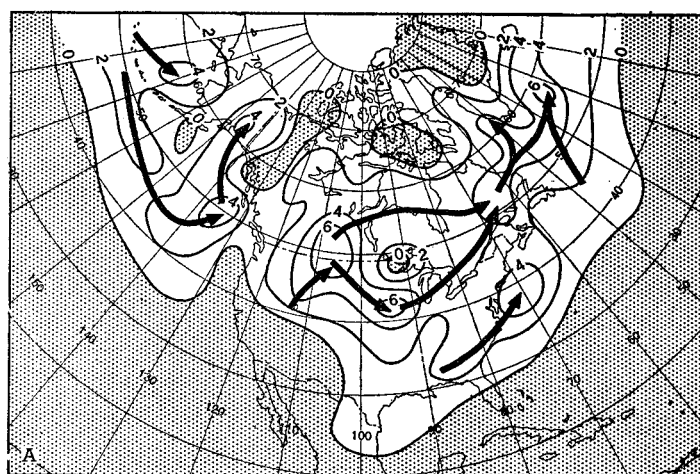


FIGURE 4.—Frequency of cyclone passages (A) and anticyclone passages (B) (within 5° squares at 45° N.) during July 1954. Unusual number of cyclones occurred to right of upper level "mean jet", however, major cyclone track was well marked in southern Canada. Cool Canadian Highs maintained mild summer weather over northeastern United States.

tant one. Curiously enough, quite a few sea level cyclonic systems (fig. 4A) occurred to the right of the "mean jet" under the area of anticyclonic shear aloft. This was in marked contrast to the relationship more frequently noted in this series of articles. Inspection, however, reveals that these were weak Lows on, or associated with, the trailing fronts of primary systems which were travelling eastward through Canada north of the daily (and mean) jet. The formation of such closed centers may well be associated with the warmth experienced in the United States and with an exaggerated sea level intensification of the southern end of the migratory westerly perturbations. In general, the primary track of significant storms lay, as usual, to the left of the mean jet and bore a normal relationship to upper level steering currents.

Stronger than normal westerlies off the United States west coast produced frequent intrusions of cool Pacific air masses. These invasions did not result in the appearance of a path of anticyclones across the Pacific coast in figure 4B because only closed high centers are tracked in Chart IX. Usually the Pacific surge formed a closed center first over the Plateau or a mountainous area to

the north, and frequently it was joined or reinforced by a polar High. The major anticyclone track was from Manitoba southeastward through northern Ohio thence eastward off the coast. Thus there was a fairly sharp crossing of the mean 700 and 200-mb. flow patterns toward higher heights and increasing anticyclonic vorticity aloft. Also, the crossing occurred where the continental "mean jet" was weakest and the cyclonic vorticity was least.

TEMPERATURE AND PRECIPITATION

Mean temperature departures for the month (Chart I-B) were closely related to the mean circulation features at 700 mb. The mid-latitude cyclonic fetch of westerlies off the west coast and the maritime intrusions previously mentioned effected below normal temperatures from the far Northwest (-4° F. in Washington) south-southeastward through eastern California. Coastal California was warm as frequently happens when cool air fills the interior valleys and the sea breeze is minimized. Cooler than normal conditions also prevailed over the Northeast and Great Lakes areas under generally below normal heights and northwesterly cyclonic flow. Polar air accompanying the Canadian Highs (fig. 4B) maintained fairly pleasant summer weather. The Florida peninsula was also slightly cooler than normal under a weak upper level trough.

However, the greater portion and, roughly, the geographic center of the United States was warmer than normal. Monthly temperatures averaged nearly 6° F. above normal in parts of South Dakota, Tennessee, and Texas. Southeastern Kansas and northeastern Oklahoma averaged 8° above normal with adjacent areas of Kansas, Missouri, Oklahoma, and Arkansas more than 6° above normal. Thus the warm upper level anticyclone and above normal heights provided a shield against prolonged or pronounced cold air intrusions while affording optimum opportunity for insolation.

Figure 5 shows the peregrinations of the 700-mb. 5-day mean anticyclone during July. In June the mean High was central over Georgia-Alabama, but it began to retrograde at the end of the month [1]. Its continued retrogression during July was one of the notable features of the month. The upper level anticyclone moved slowly westward during the first half of July. It dominated the lower Mississippi Valley continuously until rapid and more irregular movements became evident on the 19th. These culminated in a splitting of the mean High at the end of the month. While it prevailed over the central United States extreme temperatures were observed over fairly wide areas.

Figure 6 shows the absolute maximum temperature (upper numeral) of record through 1953; the lower numerals are the July 1954 maxima. Thus, Sheridan, Wyo., tied its record maximum of 106° F.; Caspar, Wyo., set a new record of 104° ; etc. Table 1 shows (from currently available records) where and when absolute maxima were broken.

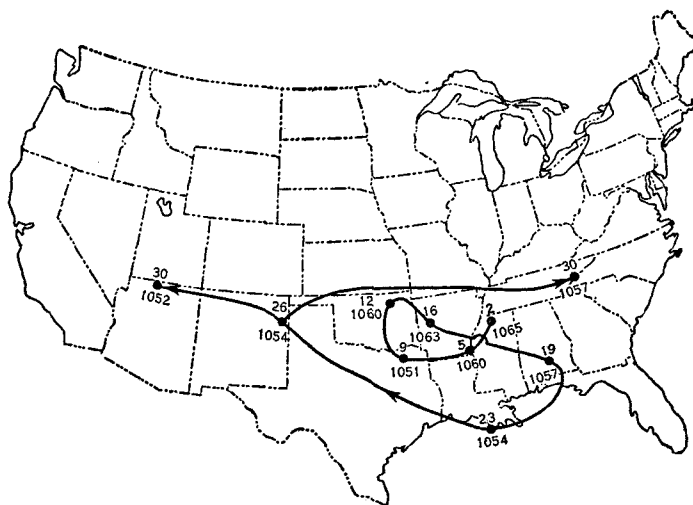


FIGURE 5.—Position and intensity of 5-day mean High (at 700 mb.) for July 1954. Dates (upper numerals) are mid-days of overlapping 5-day periods; lower numerals are intensity in tens of feet. Slow retrograde movement of anticyclone and its domination of mid-continent area are evident for first half-month.

Inspection of figure 6 also reveals that many stations of the Central and East Central States, where new maximum records were not set, came within one or two degrees of their all-time highest temperatures. These eastern extensions of extreme warmth came with the passage of cyclonic centers to the north. In the quickened westerly flow of the warm sector, the hot air of the Midwest was advected eastward. Although this air was modified in its travels, a number of new absolute maxima were established in eastern States and near record temperatures were fairly common. These conditions (in the East) were mainly temporary with relief supplied by passage of the cold front.

In the Midwest, however, the heat was both more intense and most persistent. At Wichita, Kans., the maximum temperature was 100° F. or over on 20 days of July. The average maximum for the month was 102.6° , the extreme, 113° (1° below the absolute maximum). The mean monthly temperature was 89.3° , some 8.4° above normal—the hottest month on record!

Appreciation of the total effect of such temperatures as these is incomplete without precipitation data. Chart III, the July precipitation anomaly, indicates that under the strong upper level anticyclone precipitation was totally inadequate. From west central Texas east-northeastward

TABLE 1.—Value and date of new absolute maximum temperature records established during July 1954

Station	Temperature ° F.	Date	Station	Temperature ° F.	Date
Casper, Wyo.....	104	12	Columbia, Mo.....	113	14
Colorado Springs, Colo...	100	13	St. Louis, Mo.....	115	14
North Platte, Nebr.....	112	11	Springfield, Ill.....	112	14
Norfolk, Nebr.....	113	11	Youngstown, Ohio.....	100	14
Tulsa, Okla.....	112	14	Huntington, W. Va.....	105	14
Dallas, Tex.....	111	25	Greensboro, N. C.....	102	14
Austin, Tex.....	109	26	Frederick, Md.....	102	31
Springfield, Mo.....	113	12	Wilmington, Del.....	102	31

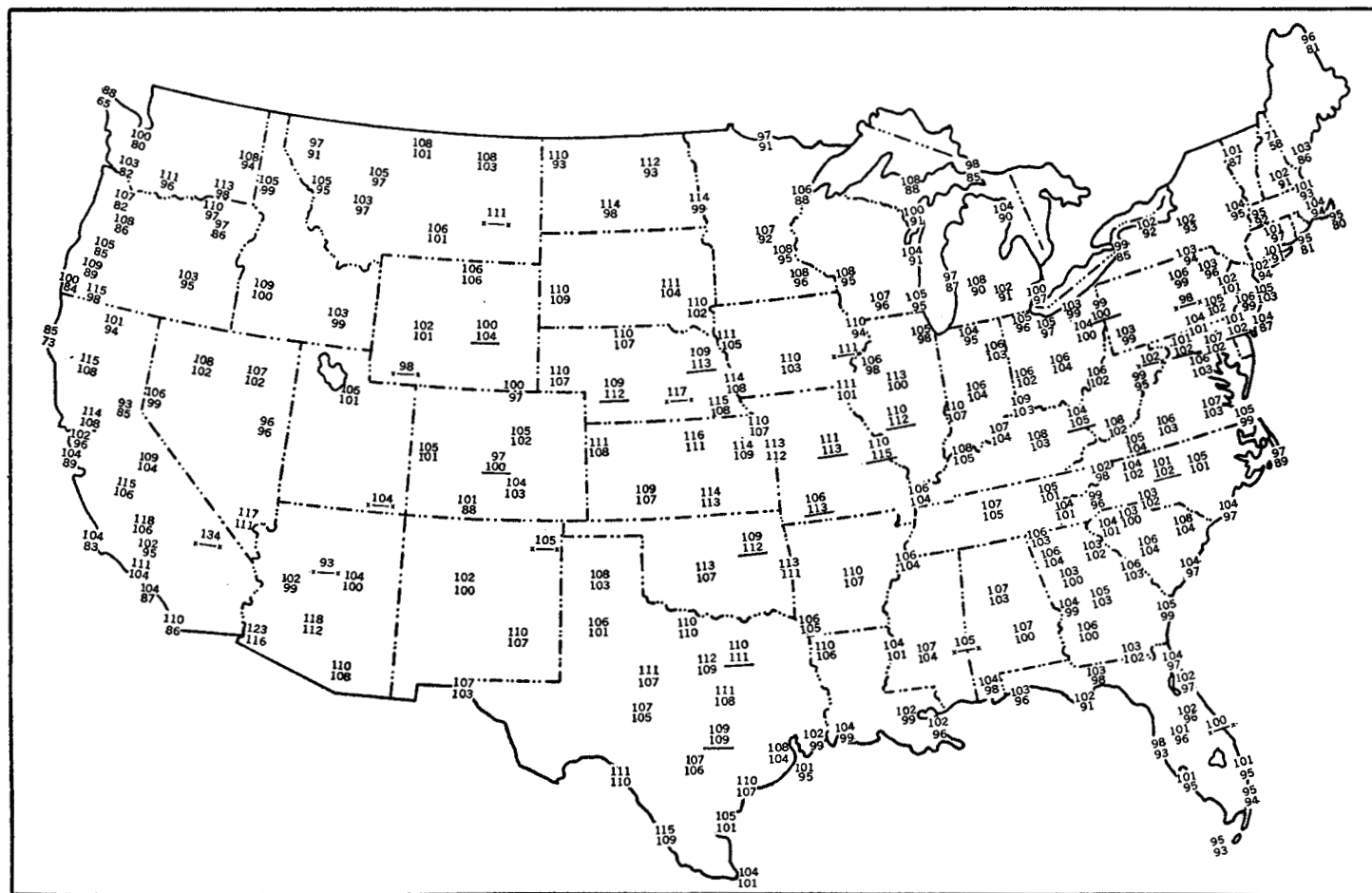


FIGURE 6.—All-time maximum temperatures of record through 1953 (upper numerals) and maximum observed during July 1954 (lower numerals) in °F. New absolute maxima are underlined; x—x indicates data not available. Note many new maxima and approach to all time records from the Rocky Mountain States to the east coast.

to western Tennessee and north-northeastward through Oklahoma, Kansas, Missouri, Iowa, and eastern Nebraska precipitation amounts were less than half of normal. Oklahoma received only 24 percent of normal precipitation, Arkansas and Missouri 39 percent, Nebraska 42 percent, Iowa 48 percent, Kansas 49 percent, and northwestern Texas from 0 to 25 percent. As can be readily imagined, the combination of record or near record temperatures and strongly deficient precipitation brought about major drought conditions. There is not currently available any total index of drought conditions which measures the combined effect of temperature and precipitation. However, soil and plant moisture losses with temperatures over 100° F. and appreciable air movement were enormous.

Thus July brought the persistence and expansion of a drought regime which began to affect the central United States during late June [1]. The result of this sequence was extension of the federally recognized drought disaster area eligible for federal aid. To Colorado, Wyoming, New Mexico (where spring and early summer had been dry, and July precipitation was insufficient) and Texas (where drought continued) were added Oklahoma and Missouri. Six other States appealed for such aid:

Kansas, Arkansas, Tennessee, Alabama, Georgia, and Kentucky. Drought conditions also threatened a number of eastern States. From the Carolinas to New York precipitation was generally less than normal (New Jersey received only 36 percent of normal July precipitation) and in many eastern localities the drought was severe.

The pattern of appreciable precipitation (Chart III) can be reasonably associated with the mean circulation. In the far Southwest (Arizona, Utah) shower activity was more marked than usual in the western moist tongue. These moist air injections were propagated northeastward and rains were noted in Colorado, western Nebraska, and the Dakotas. Propelled by the circulation around the upper level anticyclone this moisture contributed to above normal precipitation in Minnesota, Wisconsin, Illinois, Indiana, Michigan, and Ohio. These rains were of the frontal and air mass shower type with instability usually released by the influence of westerly perturbations which were centered farther north, or by overrunning of the cool Highs. Precipitation was also noted from eastern Ohio southward along the Appalachians as the moisture continued its trajectory around the upper level High. In Florida, precipitation was above normal under the weak trough aloft, and the immediate Gulf Coast from Louisiana

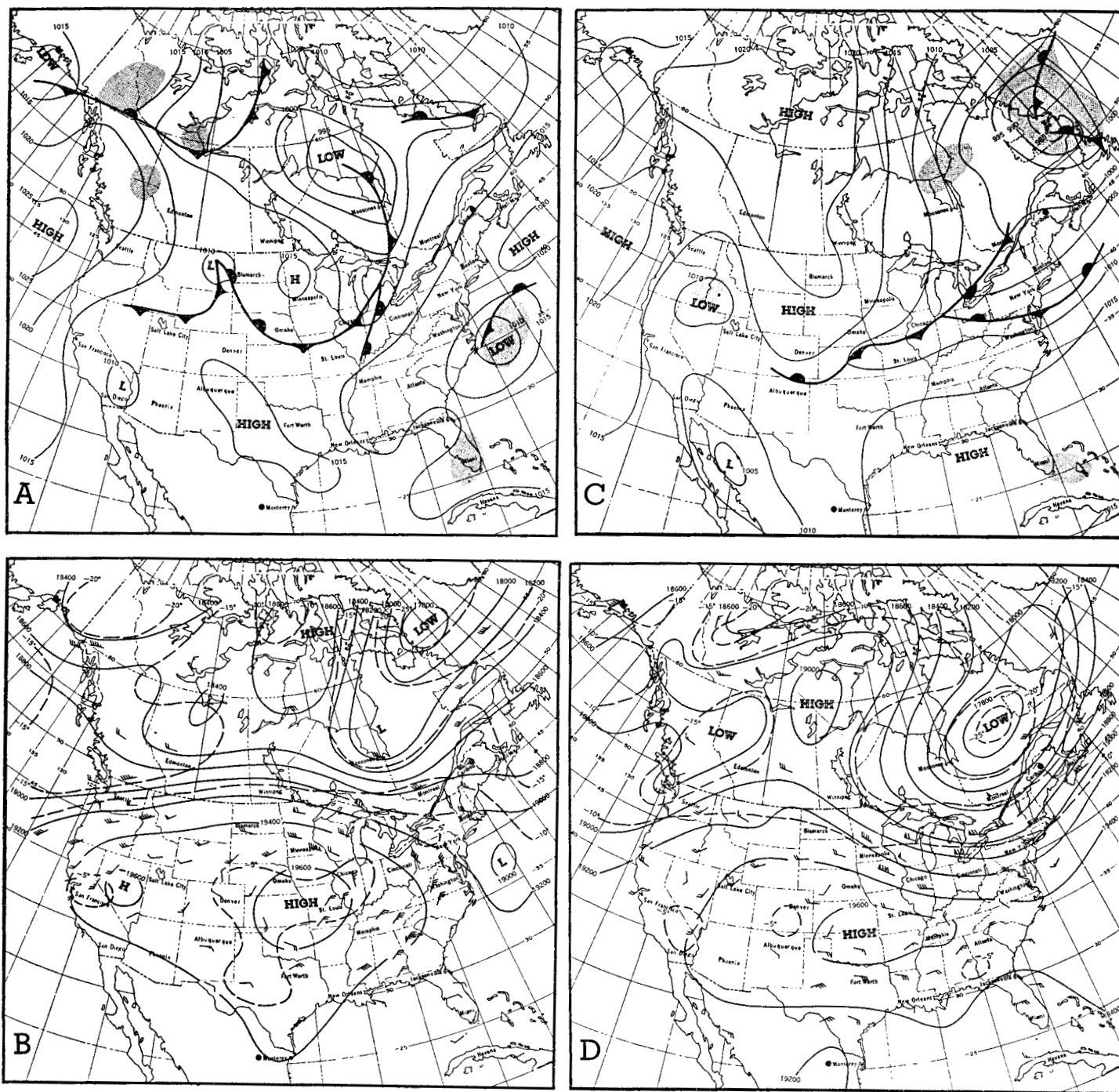


FIGURE 7.—(A) Sea level synoptic map, 1:30 p. m. EST, July 12, 1954. Extreme temperatures occurred over central United States in advance of the cold front. (B) 500-mb. map 10 p. m. EST, July 12, 1954. The air over Missouri was turning anticyclonically and trajectories show advection from the west along northern edge of the High. Note well-marked jet to north. (C) Sea level synoptic map, 1:30 p. m. EST, July 14, 1954. Note similarity to frontal trough of the 12th over central United States but contrast in gigantic "warm sector" across the East Central States. New maximum absolute temperatures were established over a wide area preceding the cold front passage. (D) 500-mb. map, 10 p. m. EST, July 14, 1954. Ridge now extended eastward much more prominently than on the 12th. Westerly winds aloft occurred almost all the way to the east coast and the jet to the north showed winds of 70 knots or better at this level.

to northwestern Florida also received above normal precipitation. The latter was due to a small tropical disturbance which affected Southern Louisiana at the month's end (Chart X) as the upper level anticyclone split in two.

In the far Northwest, coastal Washington and Oregon had above normal precipitation under the cyclonic south-

westerly flow and below normal heights at 700 mb. The moisture track extended eastward through northern Idaho and western Montana and was generally associated with the passage of trailing fronts. Elsewhere the arid sections of California, eastern Oregon, and southern Idaho received little or no precipitation.

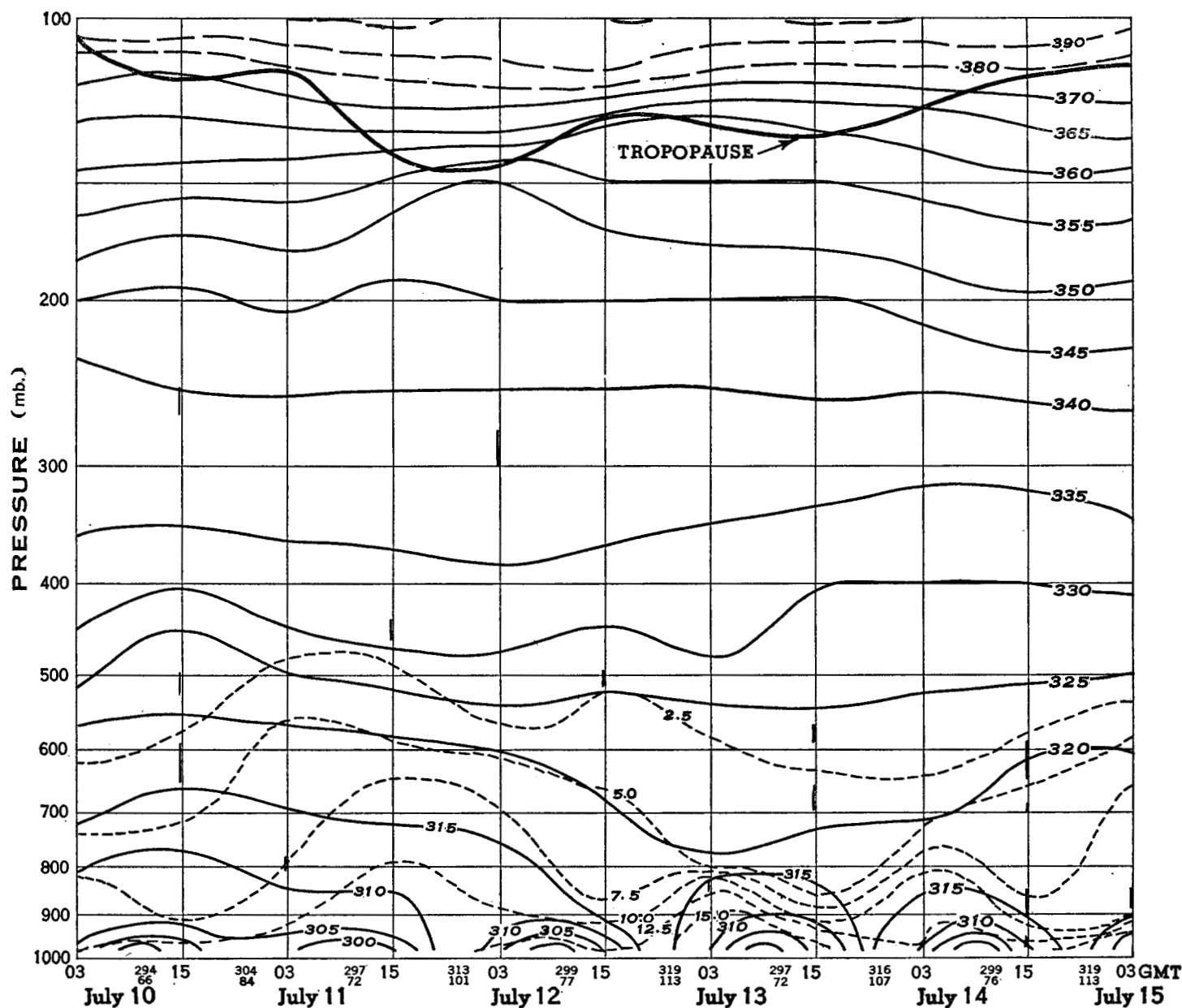


FIGURE 8.—Time section of soundings at Columbia, Mo., July 10-15, 1954. Vertical (pressure) scale is logarithmic. Potential temperatures are indicated by solid lines where analyzed for every 5° C. and by dashed lines where analyzed for every 10°. Lines of equal mixing ratio are drawn for every 2.5 gm./kg. of dry air. Approximately dry adiabatic lapse rates are indicated by solid vertical lines adjacent to the portion of sounding where such conditions prevailed. Maximum and minimum surface temperatures are given in ° F. and in terms of potential temperature in ° C.; they are interpolated in the time scale by estimating time of occurrence. Note frontal surface at 820 mb. on July 13, 0300 GMT.

THE HOTTEST PERIOD

The establishment of so many new absolute temperature records during July quite naturally led to some curiosity as to the structure of the atmosphere accompanying their occurrence. What follows is a brief examination pertaining chiefly to Columbia, Mo., from July 10 to 14. New records were set on the 12th (113° at Columbia and Springfield, Mo.) and on the 14th (113° at Columbia and 115° at St. Louis).

Figure 7A shows the sea level synoptic situation at 1:30 p. m. EST, July 12. The frontal trough extending from Michigan southwestward had formed east of the

Continental Divide and had been located in the eastern Dakotas on the 11th. The small Low in eastern Montana (fig. 7A) moved eastward to the Dakotas on the 13th and by the 14th this trough was similarly extending from southern Michigan southwestward to northeastern Kansas (fig. 7C). In both cases the extreme temperatures occurred in the general westerly drift which preceded the cold front passage. This flow, while by no means strong, probably assured some adiabatic warming in lower levels through downslope motion but the effect was not marked.

The 500-mb. map for 10 p. m. EST of the 12th (fig. 7B) shows the strong upper level anticyclone centered

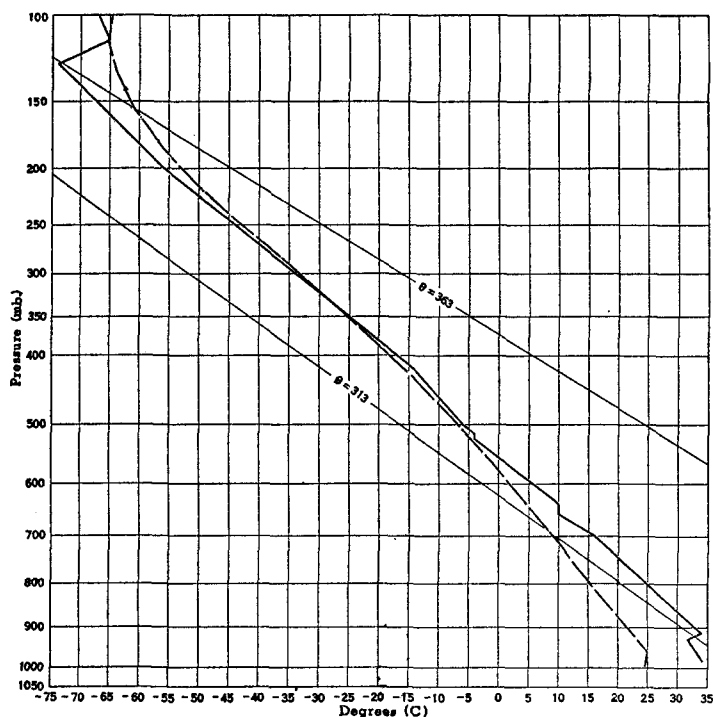


FIGURE 9.—Sounding at Columbia, Mo., at 10 a. m. EST, July 12, 1954 (solid line) compared with a short term July normal sounding at St. Louis (dashed line). Extreme warmth and steep lapse rate are apparent in lower levels. Minor isothermal layers may be questionable. A well-marked, high, cold tropopause was a characteristic of soundings for this period.

over the Kansas-Missouri border. Winds were north-northeasterly over Missouri but their trajectories were strongly anticyclonic and the vertical structure might well be expected to show the characteristics of subsiding air. Of further interest is the strong jet to the north where winds were 50 knots or better (at the 500-mb. level) near the Canadian border. On the 14th (fig. 7D) the 500-mb. High was still located near the Kansas-Missouri border but a much stronger ridge extended eastward through Tennessee and North Carolina. Winds north of the ridge line and in mid-United States latitudes were westerly aloft from the Central Plains eastward to the east coast. The jet was again well marked with winds of 70 knots or better over the lower Lakes at 500 mb. Absolute maximum temperature records were set from Tulsa, Okla., as far east as Greensboro, N. C., in one gigantic "warm sector."

Figure 8 is the time section of the soundings for Columbia, Mo., from July 10 to 15. The following general observations are possible.

1. The lower troposphere warmed from the 10th to the 12th. This warming was accompanied initially by increasing values of the mixing ratio and seemed due partly at least to warm air advection at lower levels as cool air gave way to warm.

2. During this same period cooling was evident above 200 mb. with some evidence of vertical stretching in the

upper middle troposphere. The tropopause was well marked and lowered during this interval.²

3. The tropopause rose fairly steadily from the 12th on, and the upper troposphere gradually grew warmer. However, the tropopause was high throughout this sequence and colder than normal (see fig. 9).

4. From the 10th through the 13th there was probably a general stretching superimposed upon other effects. No single or simple subsidence inversion could be identified through available soundings. It is possible that subsidence was effective through deep layers and that any tendency to stabilize the lapse rate was negated by insolation.

5. Insolation undoubtedly played an important role. On the 12th, 13th, and 14th percentages of possible sunshine were 99, 100, and 100 respectively and solar radiation measured 743.7, 738.9 and 736.1 gm. cal./cm.² respectively at Columbia. From rough calculations S. Fritz has estimated (private communication) that with incoming radiation of this order, a warming of the troposphere below 500 mb. of about 1° to 2° C./day may be realized. In a more stagnant situation during August 1953 [3] a warming of about 1° C./day through most of the troposphere was apparently due to a combination of subsidence and solar radiation.

6. The surface potential temperature maxima in the afternoons of the 12th and 14th corresponded to values of potential temperatures occurring at relatively high levels in lower troposphere. Cloud evidence would not suggest any deep unstable layers and it may be inferred that either subsidence was occurring or that the super-adiabatic conditions prevailed only near the ground.

The lapse rate at 1500 GMT (9 a. m. EST) of the 12th is compared to the normal in figure 9. It is clear that the tropopause was well marked, colder than normal, but perhaps about average in height (the normal in this case, however, is the average of only a few years of July soundings at St. Louis) [4]. The best-marked inversion, at 910 mb., appears to be the remnant of the strong ground-radiation inversion. The other two stable zones at 650 and 520 mb. cannot be traced through the series of soundings and also appear higher than might be expected of subsidence inversions. Extreme warmth of the sounding on the 12th (lower levels) is apparent by its displacement from normal.

The absence of a well-marked, persistent subsidence inversion in a somewhat similar situation has been noted by Klein in a previous article [3] and substantiated by a more thorough investigation by Fritz (private communication). It seems likely that these inversions persist only when a sea level anticyclone is present under the

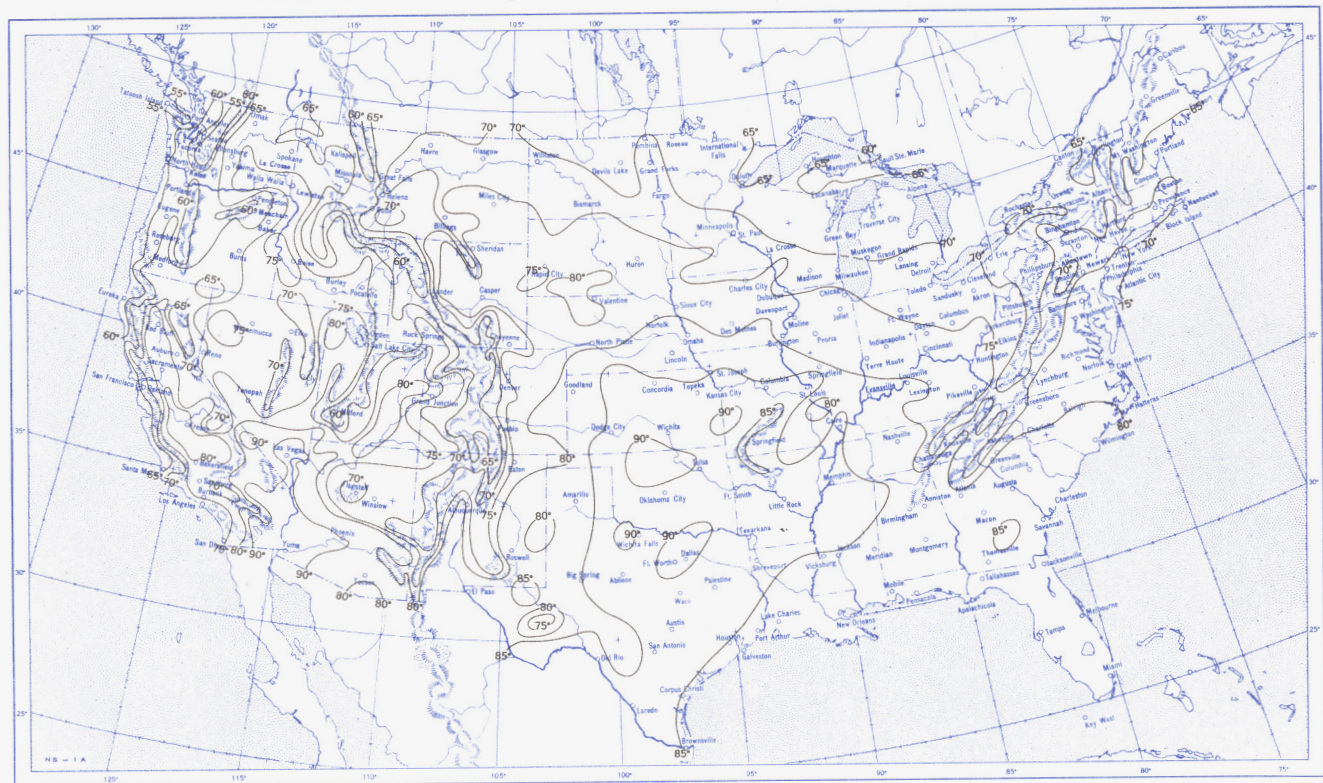
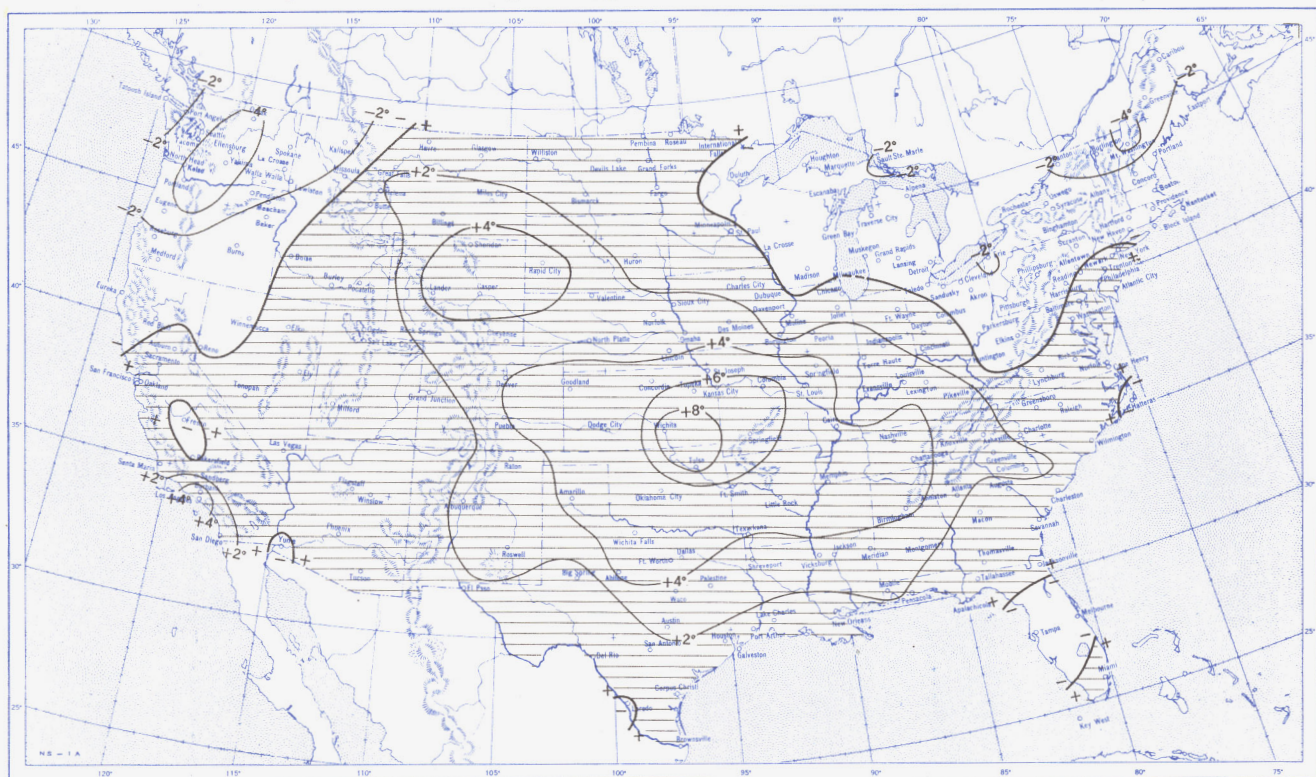
² In these soundings the tropopause was not only the coldest temperature of the soundings but also the point where the lapse rates changed from near adiabatic to isothermal or (more frequently) to increasing temperatures with height.

upper level High and when low level heating by solar radiation is not adequate to destroy them.

In summation there was no single outstanding characteristic or process which appeared to dominate during the occurrence of the absolute maximum temperatures. There was evidence of downslope motion in low levels, subsidence through deeper levels, warm air advection, and strong insolation. Furthermore, the influence of the marked jet to the north remains to be evaluated.

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2. H. F. Hawkins, "The Weather and Circulation of July 1953," *Monthly Weather Review*, vol. 81, No. 7, July 1953, pp. 204–209.
3. W. H. Klein, "The Weather and Circulation of August 1953—Featuring an Analysis of Dynamic Anticyclogenesis Accompanying Record Heat and Drought," *Monthly Weather Review*, vol. 81, No. 8, August 1953, pp. 246–254.
4. U. S. Weather Bureau, "Upper Air Average Values of Temperature, Pressure and Relative Humidity Over the United States and Alaska," *Technical Paper No. 6*, Washington, D. C., April 1949.

Chart I. A. Average Temperature ($^{\circ}\text{F.}$) at Surface, July 1954.B. Departure of Average Temperature from Normal ($^{\circ}\text{F.}$), July 1954.

A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.

B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), July 1954.

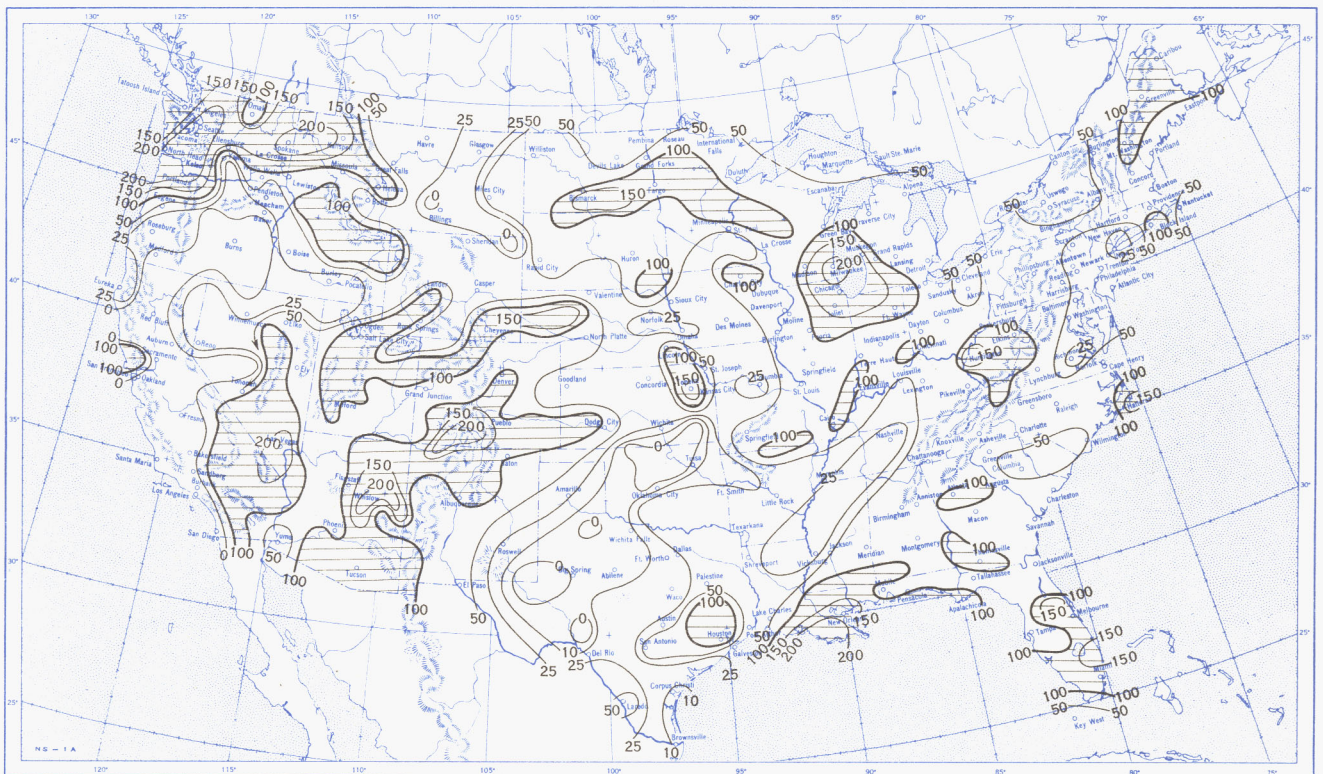


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), July 1954.

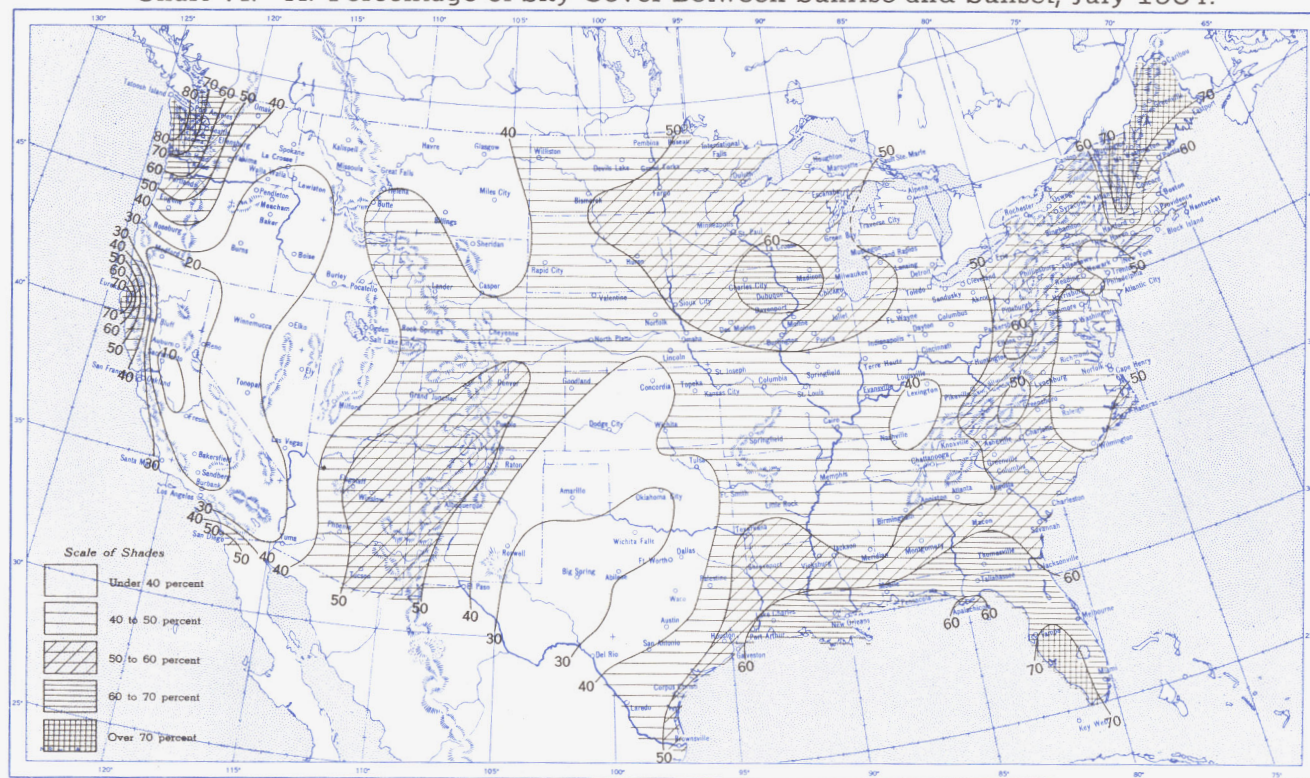


B. Percentage of Normal Precipitation, July 1954.

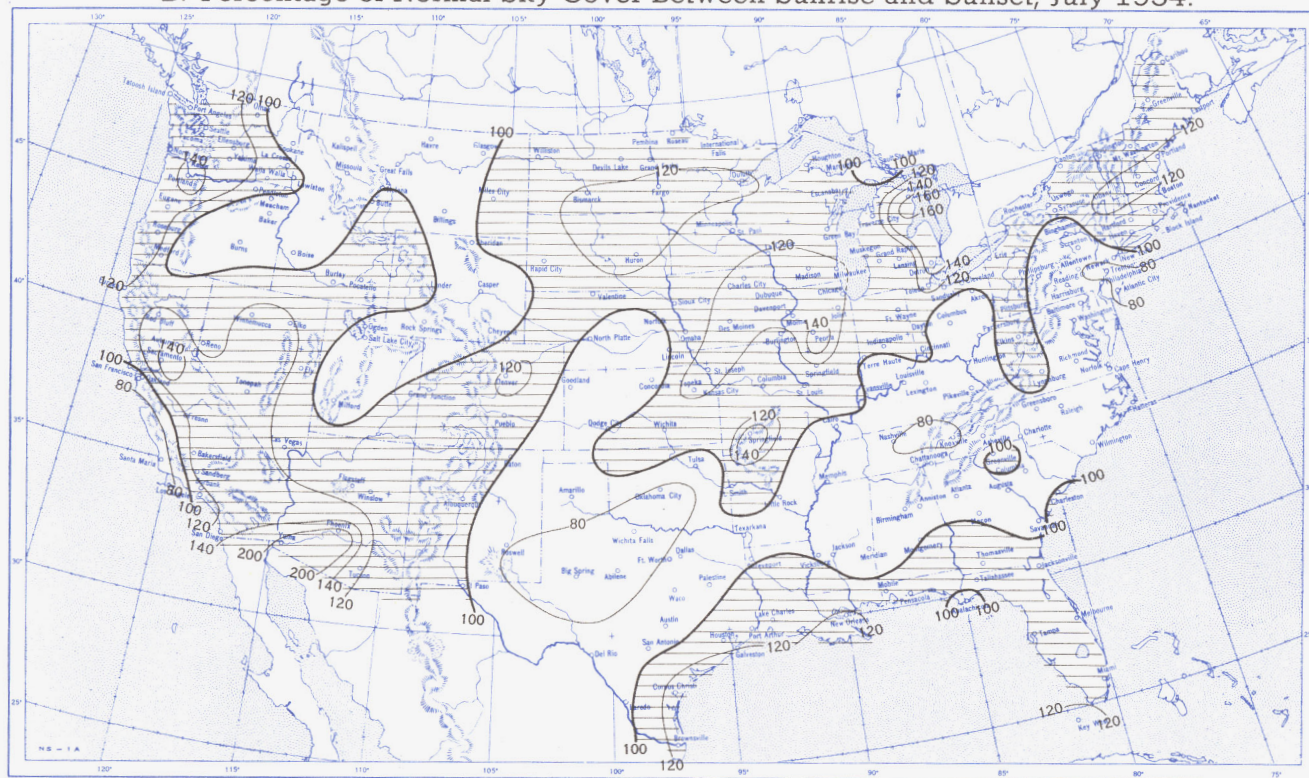


Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, July 1954.

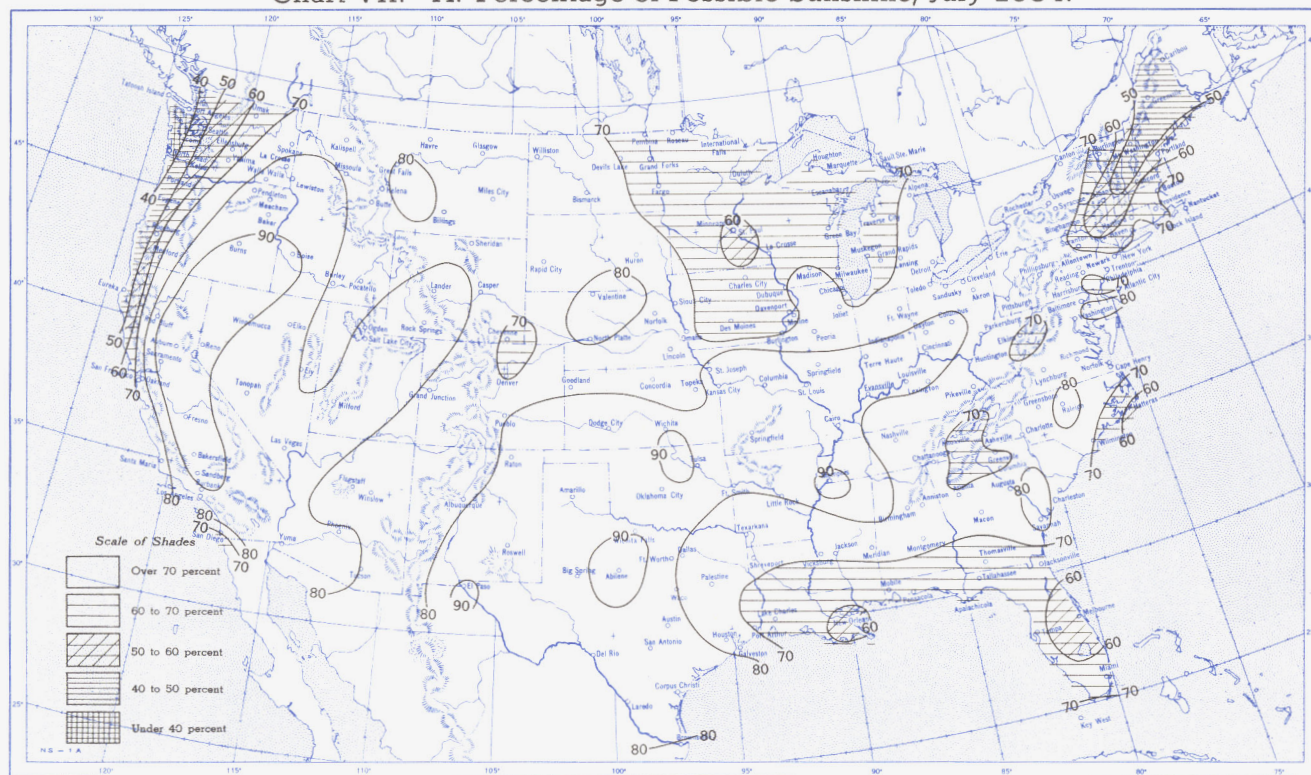


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, July 1954.

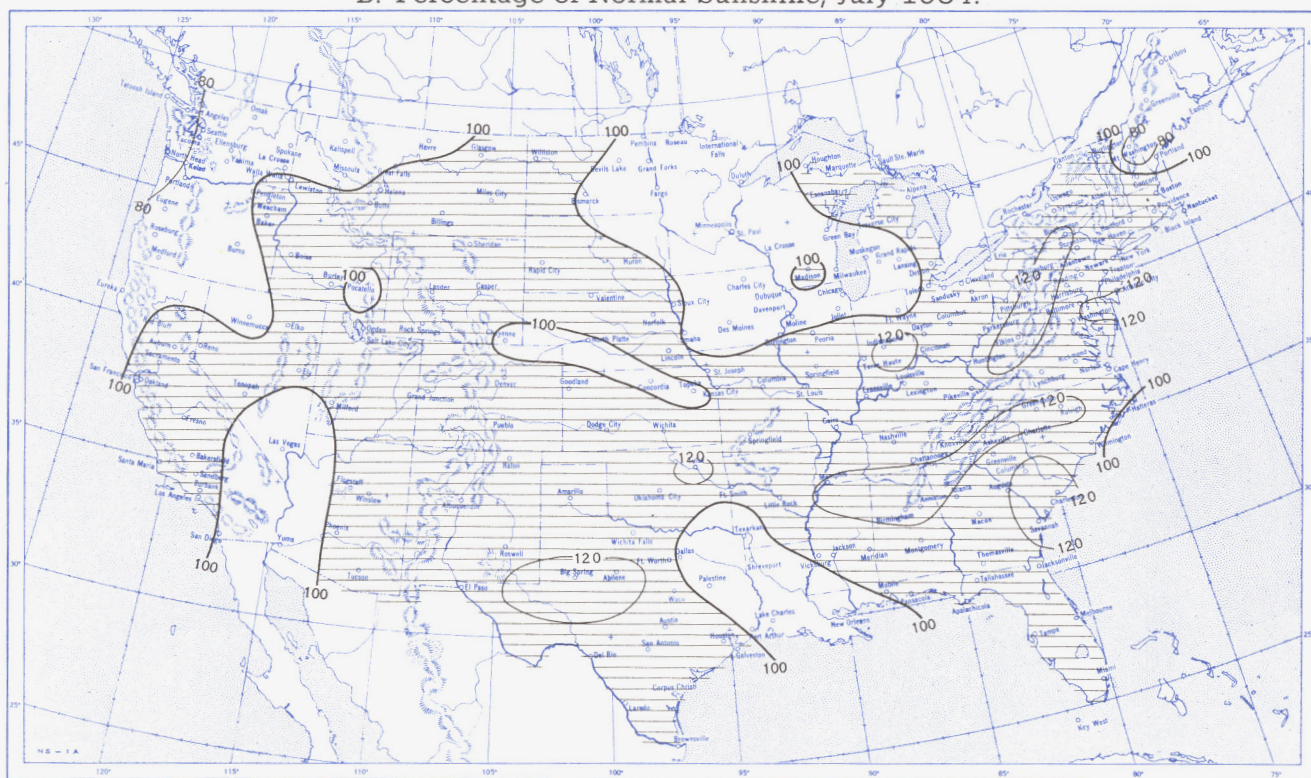


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, July 1954.



B. Percentage of Normal Sunshine, July 1954.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, July 1954. Inset: Percentage of Normal Average Daily Solar Radiation, July 1954.

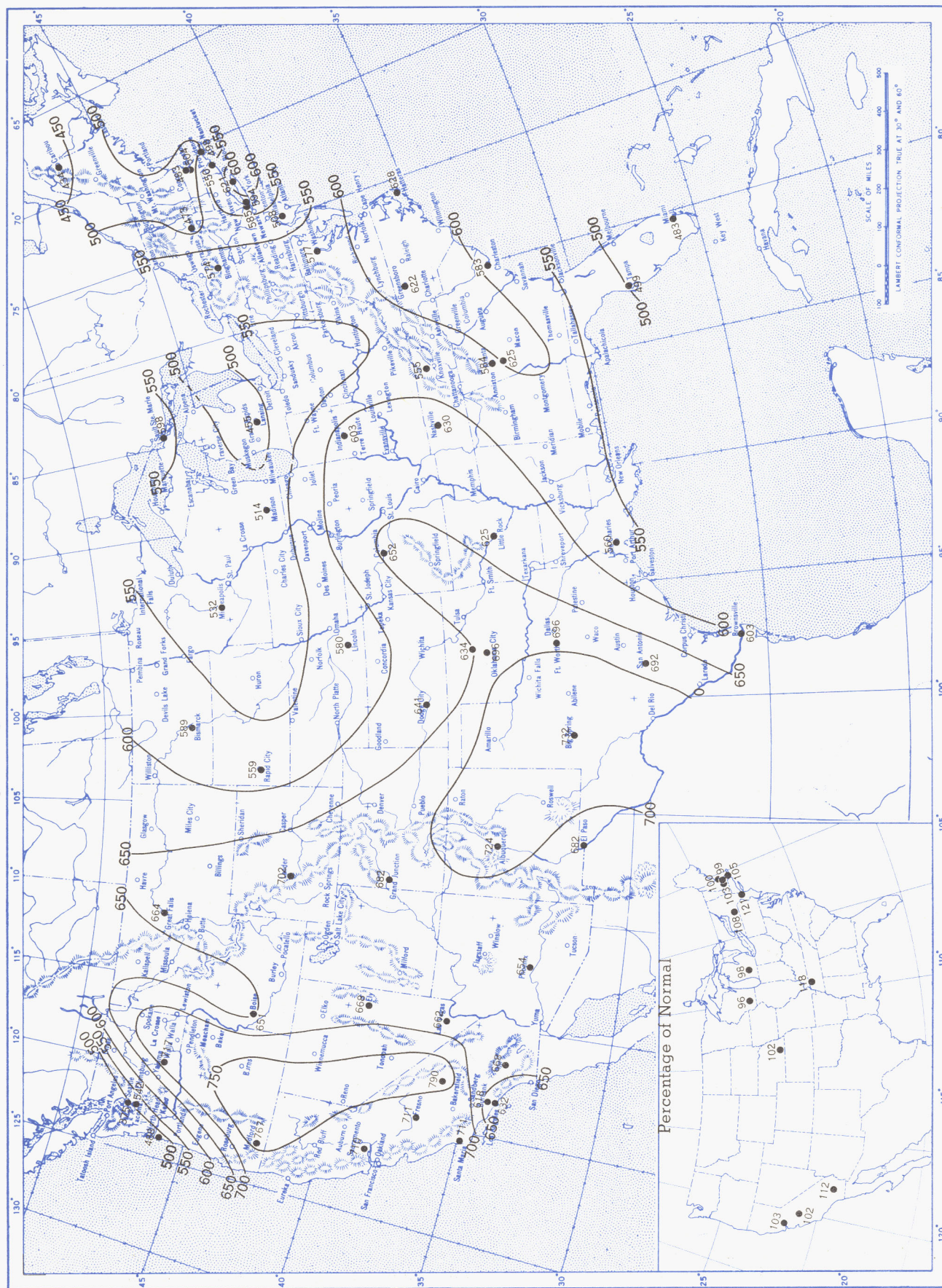
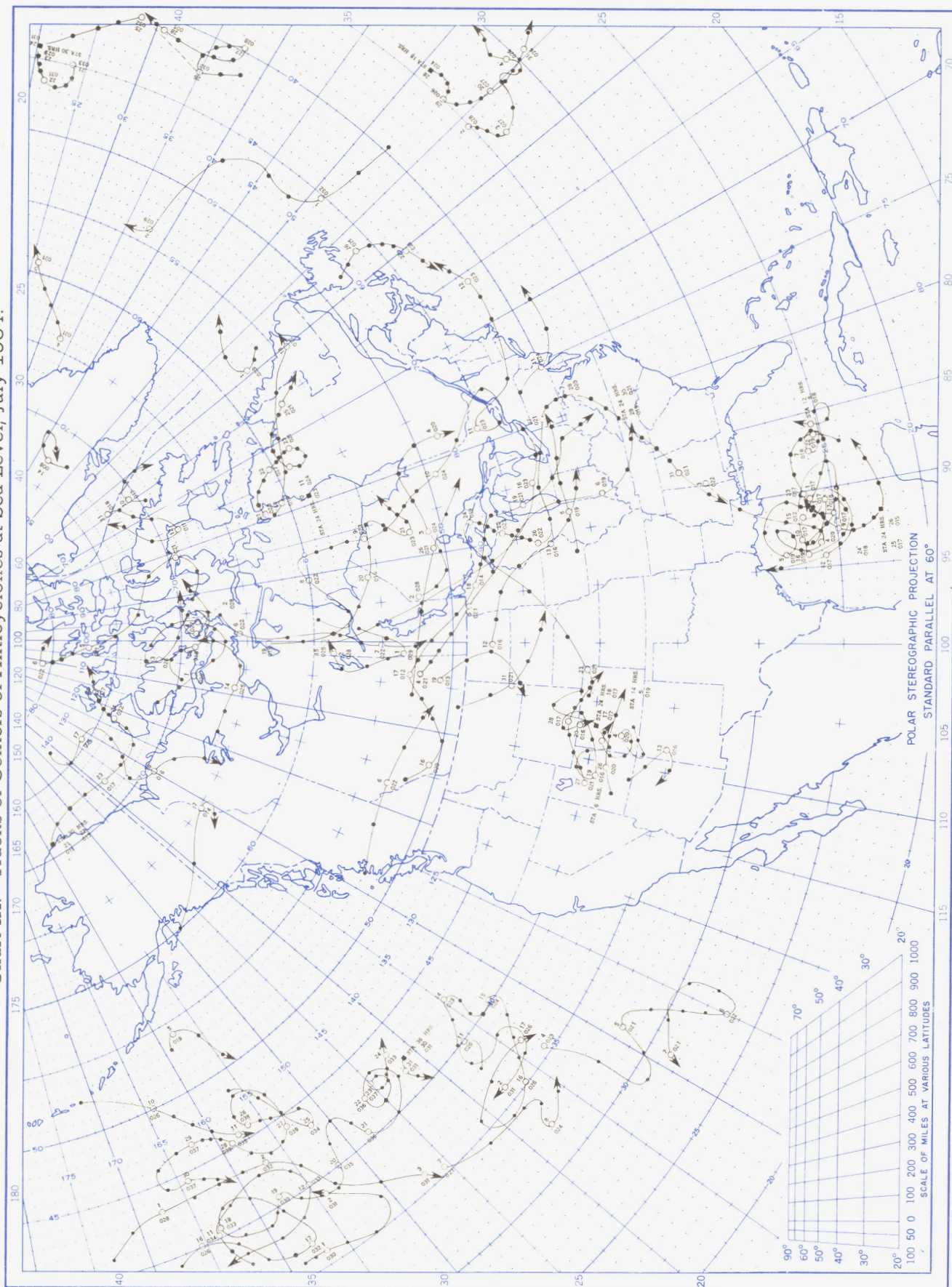


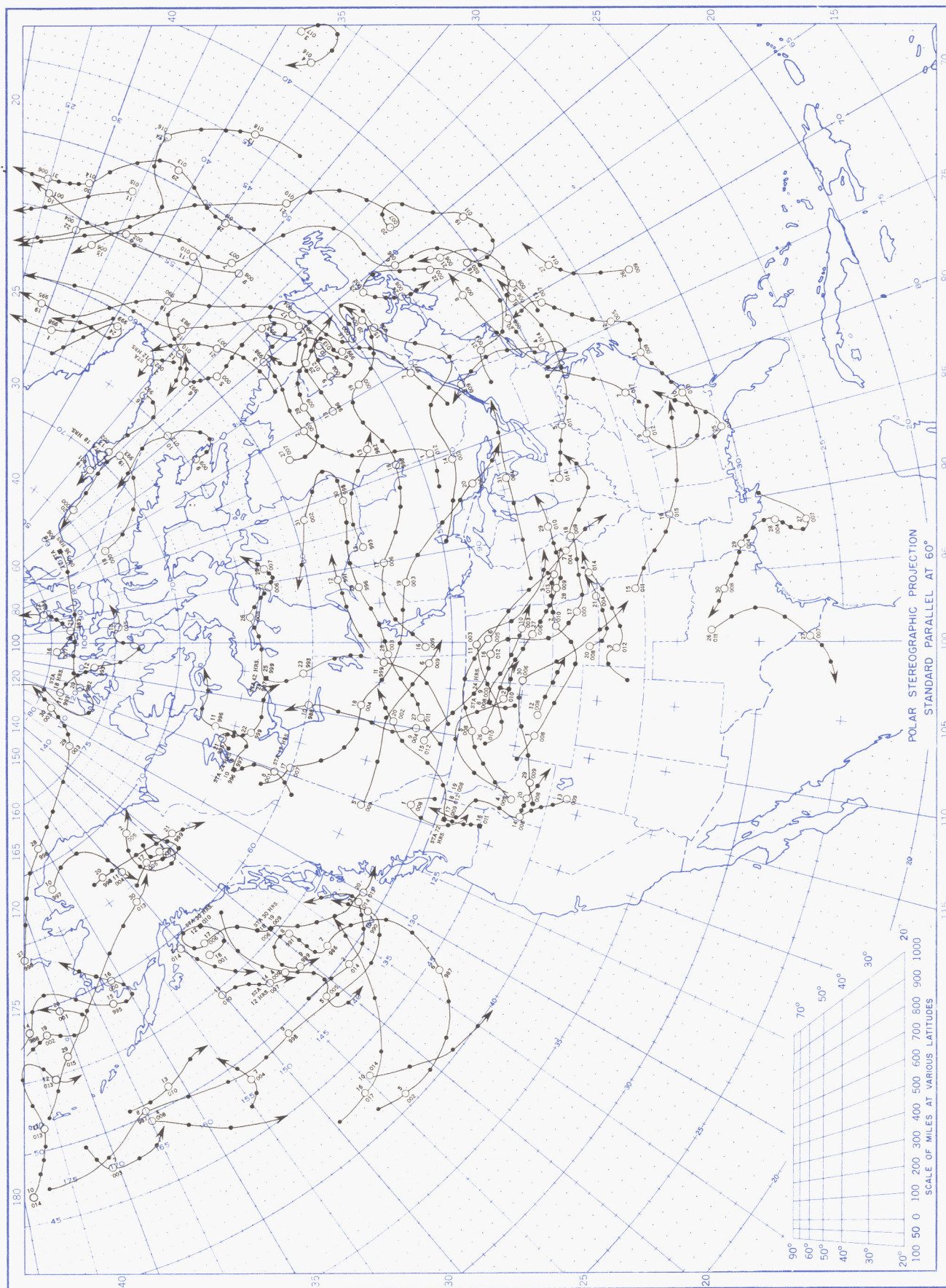
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langley (1 langley = 1 gm. cal. cm.⁻²). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, July 1954.



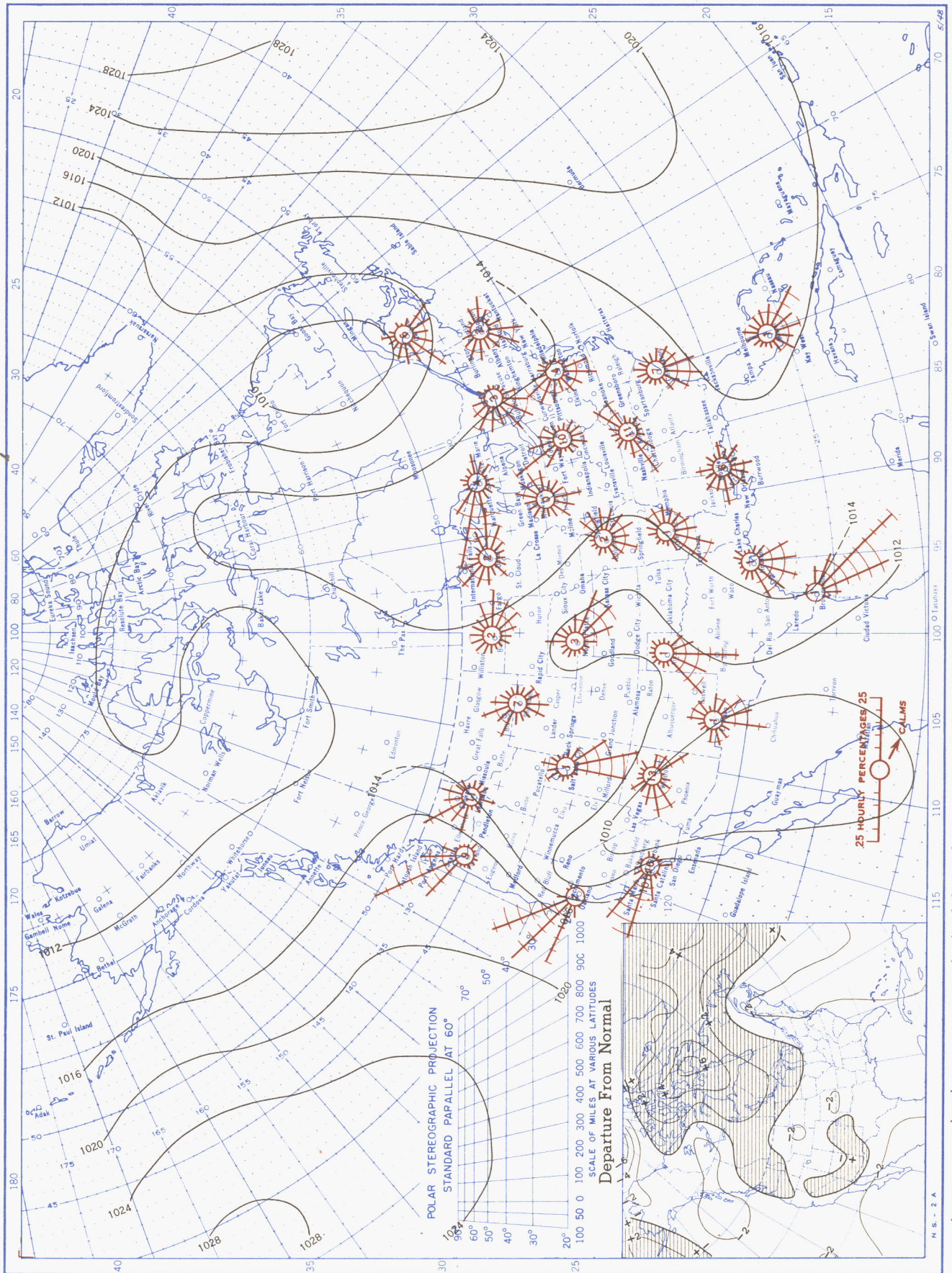
Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, July 1954.



Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, July 1954. Inset: Departure of Average Pressure (mb.) from Normal, July 1954.



Average sea level pressures are obtained from the averages of the 7:30 a.m. and 7:30 p.m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° inter-sections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), July 1954.

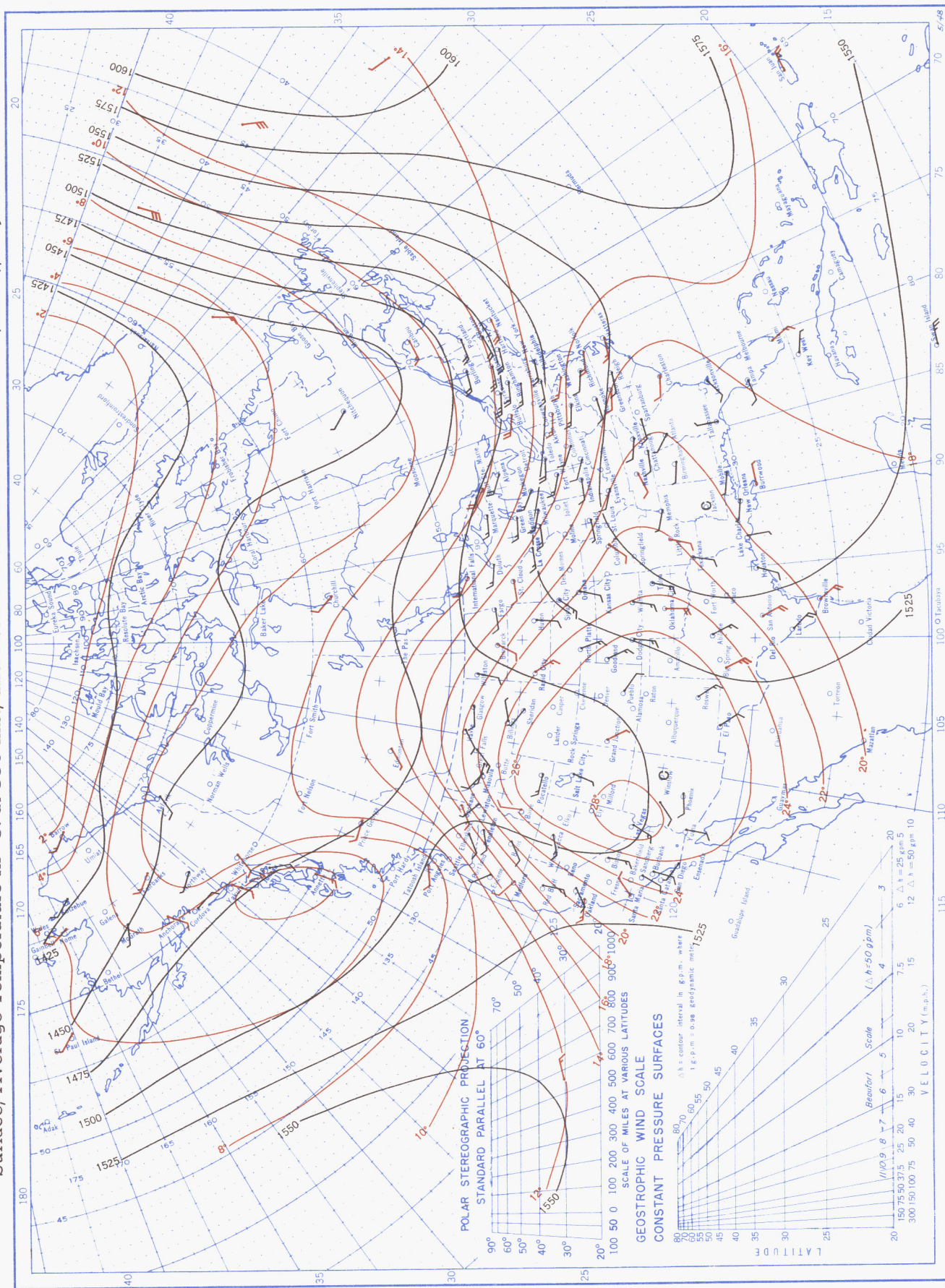
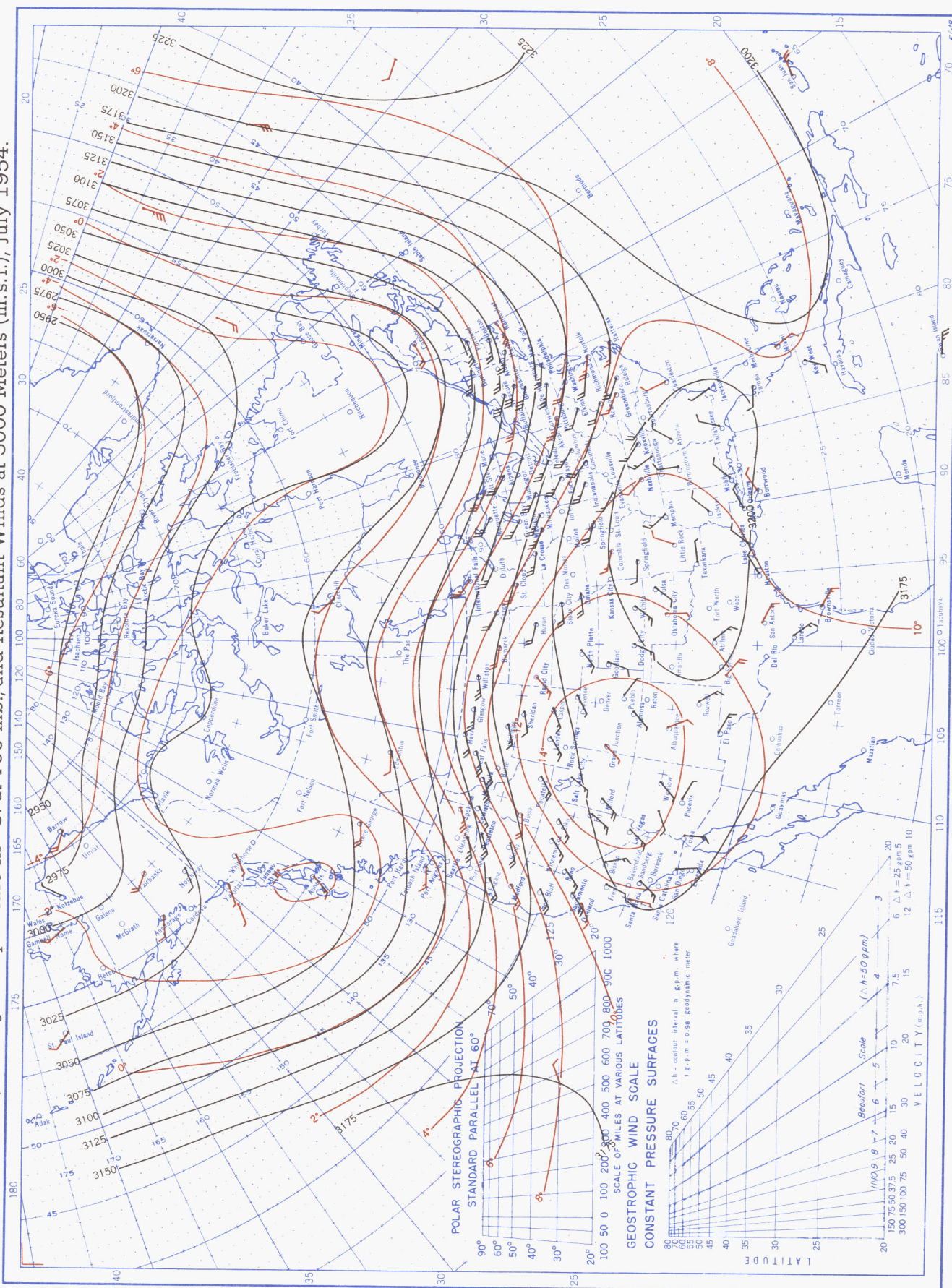
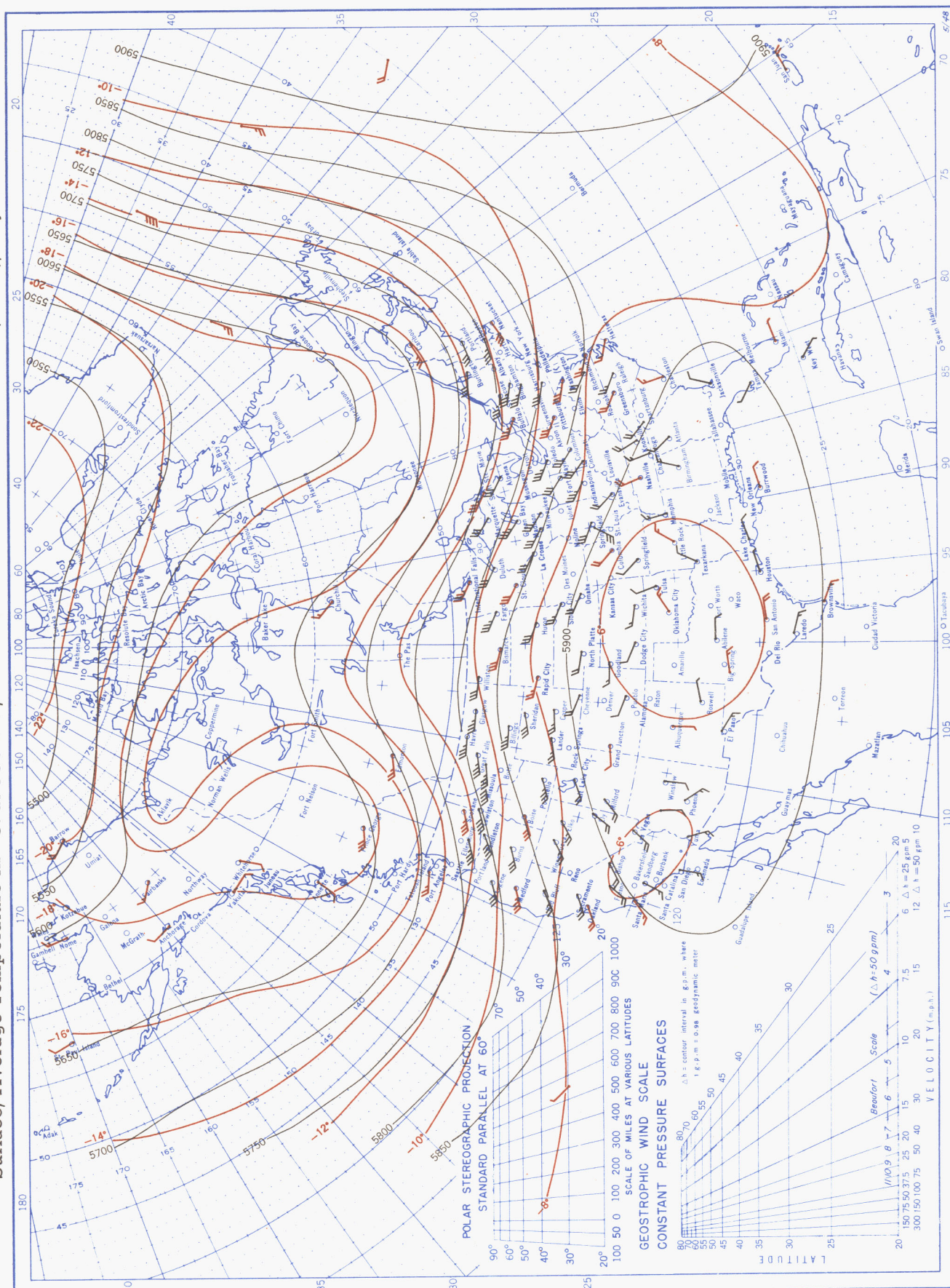


Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), July 1954.



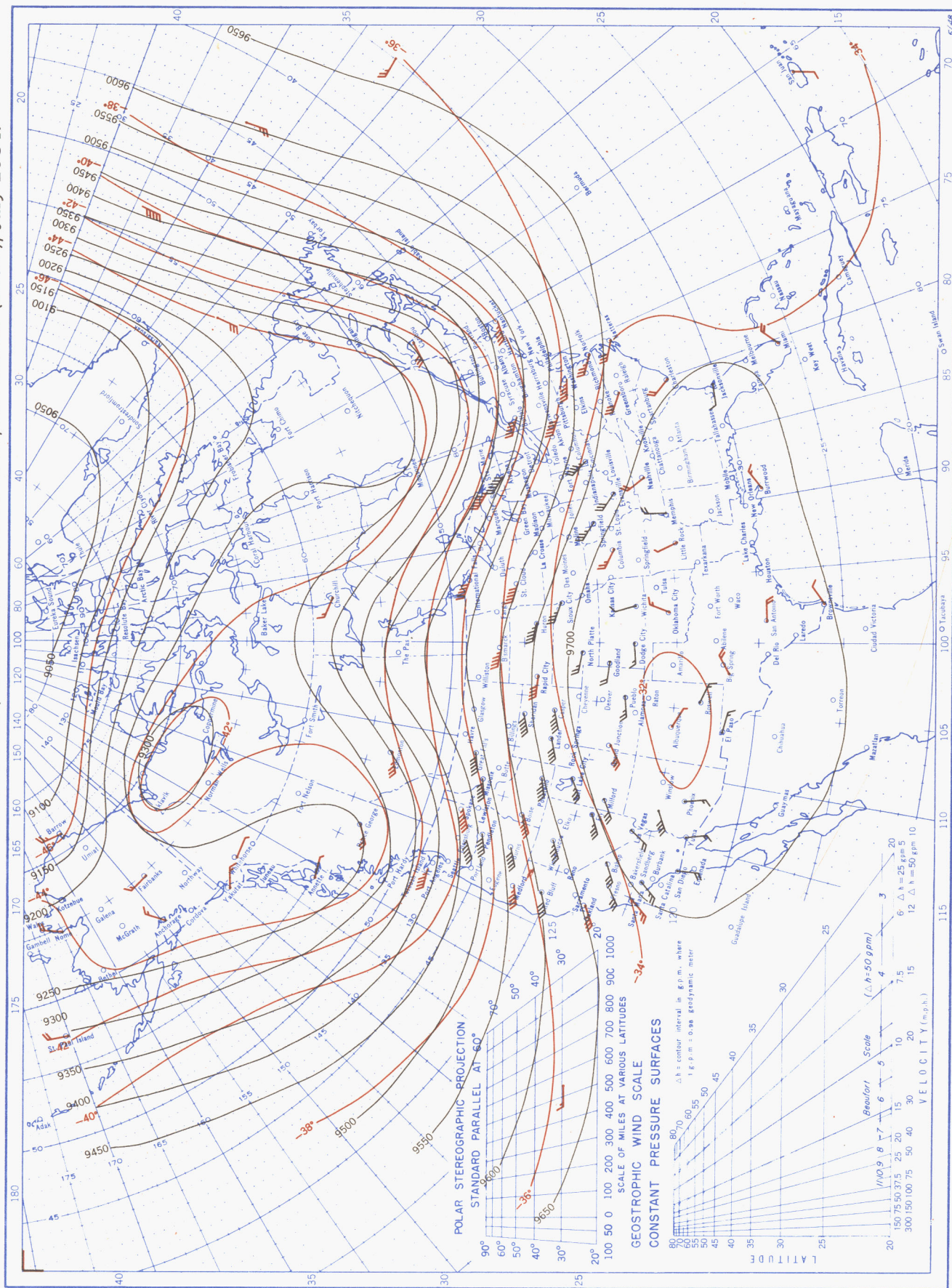
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C. at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), July 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T. Wind bars indicate wind speed on the Beaufort scale.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), July 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G.M.T. Winds shown in black are based on pilot balloon observations at 2100 G.M.T.; those shown in red are based on rawins at 0300 G.M.T. Wind barbs indicate wind speed on the Beaufort scale.